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UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 250

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. PROFESSIONAL PAPER July 24, 1915.

FOOD PLANTS OF THE GIPSY MOTH IN AMERICA

By

F. H. MOSHER, Entomological Assistant, Gipsy Moth and Brown-Tail Moth Investigations

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SCOPE OF THE INVESTIGATION.

Since the time the gipsy moth (*Porthetria dispar* L.) became abundant enough in Massachusetts to require treatment in order to prevent the defoliation of trees and shrubs the question of its favored food plants has been under consideration.

During the period from 1890 to 1900 an attempt was made by the State of Massachusetts to exterminate this insect, and a study of the different species of plants upon which the caterpillars would feed was made prior to 1896 and published that year by Forbush and Fernald in their report on the gipsy moth. These experiments were carried on with nearly full-grown caterpillars, a small number being confined in a jar with each food plant. If no feeding was noted in three days the experiment was repeated with other caterpillars, and if the same result was secured for this lot the food plant was considered unfavored by the caterpillars. As a result of these experiments 477 species of trees, shrubs, and plants were tested, and 458 of these were

NOTE.—This bulletin reports a series of investigations conducted in 1912, 1913, and 1914 to determine the favored food plants of the gipsy moth. The subject is of interest to entomologists and to State authorities engaged in the fight against the gipsy moth in the northeastern States.

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eaten to a greater or less extent. On 27 species the larvæ fed very slightly, and on 19 no feeding was noted.

In 1905, when work to control the gipsy moth was resumed, after a lapse of five years, it was found that the infestation had spread over such a wide territory that extermination of the moth was impossible. The following year (1906) an appropriation was made by Congress and control work to prevent the spread of this insect was commenced by the Bureau of Entomology. The infestation was so heavy in eastern Massachusetts that the principal efforts, aside from parasite introduction, was to clear the main highways in order to prevent the distribution of caterpillars through the medium of passing vehicles. As early as 1907 it was noticed by a number of observers that some species of trees were more often defoliated than others. These observations also indicated that pine was one of the species which was not readily attacked. In order to secure more information on this subject a number of experiments were carried on by the writer under the direction of Mr. A. H. Kirkland, who was superintendent of moth work for the State of Massachusetts.

The preliminary work was commenced in the spring of 1907, newly hatched caterpillars of the gipsy moth being placed in jars and furnished with pine foliage. In the feeding experiments it was not possible to induce newly hatched caterpillars to feed and develop on white pine, but when they were furnished with oak foliage no serious difficulty was encountered. Several field experiments were also carried on to determine whether a pine growth could be protected from the gipsy moth by placing bands of tanglefoot on the trees in order to prevent caterpillars from climbing to the foliage. These experiments were repeated the following season, and on account of the success of the field experiment, wherein several acres of pine growth were protected by using tanglefoot bands, it was obvious that more detailed information regarding food plants was necessary to the proper conduct of the work than had been secured from the experiments reported in 1896. Numerous field observations and several experiments of greater scope were then conducted, but in 1911 it seemed desirable to investigate, in a thorough and systematic way, the entire matter of preferred food plants. Accordingly plans were formulated to carry on an elaborate series of laboratory experiments, using first the more common trees occurring in the infested ments at the Gipsy Moth Laboratory of the Bureau of Entomology at Melrose Highlands, Mass., using first the more common trees occurring in the infested region, with the idea of taking up the rarer species, as well as the woodland shrubs and undergrowth, as soon as opportunity permitted. The experiments were arranged so that two lots of

caterpillars were fed upon the foliage of two trees of the same species, and care was taken that the foliage for each lot was always secured from the same tree. The experiments were begun by using 100 caterpillars that had just hatched for each lot, the plan being to carry on the feeding tests during each of the 6 caterpillar stages (Pl. I, fig. 1) in order to determine any variation in feeding habits in the different larval stages. In conducting these experiments special feeding trays were constructed, and the many details in the keeping of notes and records, the collection of foliage, etc., were worked out. To supplement these experiments and to give data which would furnish a check on the results secured, observations were made throughout the infested region during the summer of 1912 on the feeding habits of gipsy-moth larvæ in the field.

In 1912 the infested territory was divided into 5 sections for the purpose of determining the natural increase of the gipsy moth under varying field conditions. This work has been supervised by Mr. C. W. Minott, and the sections have been in charge of Messrs. H. R. Gooch, I. L. Bailey, E. A. Proctor, J. V. Schaffner, jr., and W. A. Shinkwin. As a part of the summer work each of these men, with one assistant, has secured notes and information on the feeding habits of the gipsy-moth larvæ. The food-plant work has now been carried on both in the field and at the laboratory at Melrose Highlands, Mass., for three consecutive years—1912, 1913, and 1914.

During the summer of 1912 and 1913 a small sublaboratory was maintained at Worcester, Mass., through the courtesy of the board of park commissioners of the city of Worcester. The experiments were in charge of Mr. C. W. Collins in 1912 and of Mr. R. Wooldridge in 1913.

The object of the work at this laboratory was to determine whether the same results would be secured from foliage gathered in an area where the gipsy moth had never become abundant and defoliation had not existed, as compared with foliage taken from the somewhat debilitated tree growth in eastern Massachusetts, where many of the trees had been defoliated one or more times. The results secured indicated that no marked difference could be noted from foliage secured from these two regions, hence the sublaboratory was discontinued at the end of the second season.

The experimental work on food plants of the gipsy moth has now reached a stage from which reasonably conclusive results may be secured. The information is of special value since it forms a working basis for reforestation in the infested areas and is of value in suggesting the tree species which will be more immune from gipsy-moth attack.

EQUIPMENT OF THE LABORATORY.

In early spring a part of the experiments were started in the laboratory, but the trays were soon transferred to a large outdoor insectary. It was found necessary to use canvas curtains on the sides of the insectary in order to shade the trays in fair weather and to prevent the entrance of excessive moisture and wind during storms.

The rearing trays used were of two sizes, depending on the age of the caterpillars. For the small larvæ the trays measured 6¼ by 6¾ by 2 inches, and trays 12¼ by 12¼ by 2½ inches (all inside measure) (Pl. I, fig. 2) were used for the larger caterpillars. These trays were of seven-eighths-inch dressed pine, having a narrow band of tanglefoot applied on the inside of the frame near the top. A piece of cotton cloth was pasted to the bottom of the tray, and two clamps were attached to the inside to hold in place a small bottle, three-fourths inch square and 4 inches long, provided with a crooked neck. The bottle was filled with water and a cork was inserted, through which was placed the end of a sprig of foliage, after which the bottle was secured in the tray by the clamp. It having developed that young larvæ exhausted themselves greatly by trying to crawl around on the cloth bottom of the tray, this covering was abandoned after the first summer's experience and a tray made of paraffined paper (Pl. II), of the proper size to fit into the wooden frames, was substituted. To replace the two brass clamps a single elbow screw was used, which held the bottle firmly but allowed it to be quickly removed.

METHODS OF CONDUCTING LABORATORY EXPERIMENTS.

Early in the spring, trees or shrubs to be used for a food supply were selected and properly tagged. Careful notes were kept of the condition of each, as well as the degree of gipsy-moth infestation upon them and upon the surrounding growth at the time the selection was made. As soon as hatching began feeding trays were given the same serial numbers as the trees or shrubs that had been previously tagged, the foliage from the same plant always being used in the same tray. One hundred newly hatched gipsy-moth caterpillars were placed on the foliage in each tray. The food was replenished daily or oftener if necessary, and a careful record of the number of caterpillars that died or molted was maintained. In cases where all the caterpillars died before pupation, new trays were started, using caterpillars one stage younger than those in the tray at the time it was discontinued.

About 60 species of trees and shrubs were tested annually at the Melrose Highlands Laboratory; and as a number of retests and special experiments were conducted each year, 150 trays were in use continu-

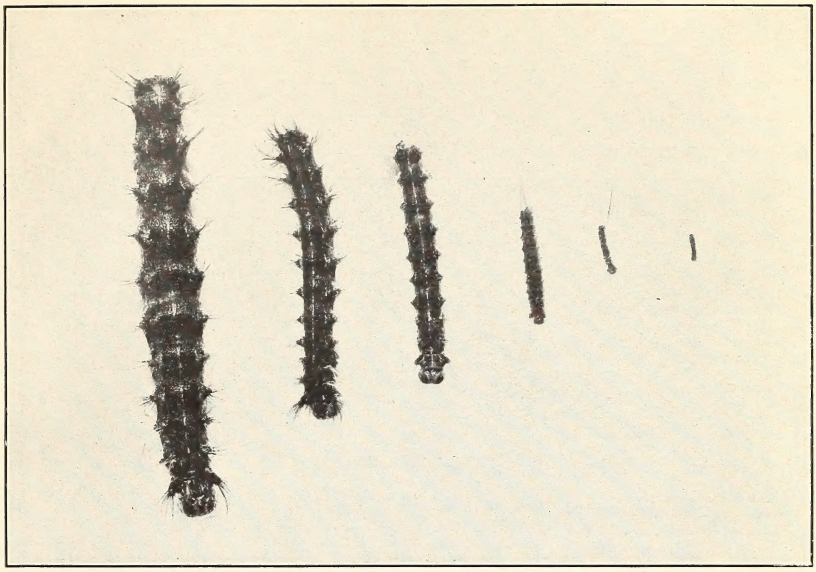


FIG. 1.—GIPSY-MOTH LARVÆ IN FIRST TO FIFTH STAGES. NATURAL SIZE. (ORIGINAL.)

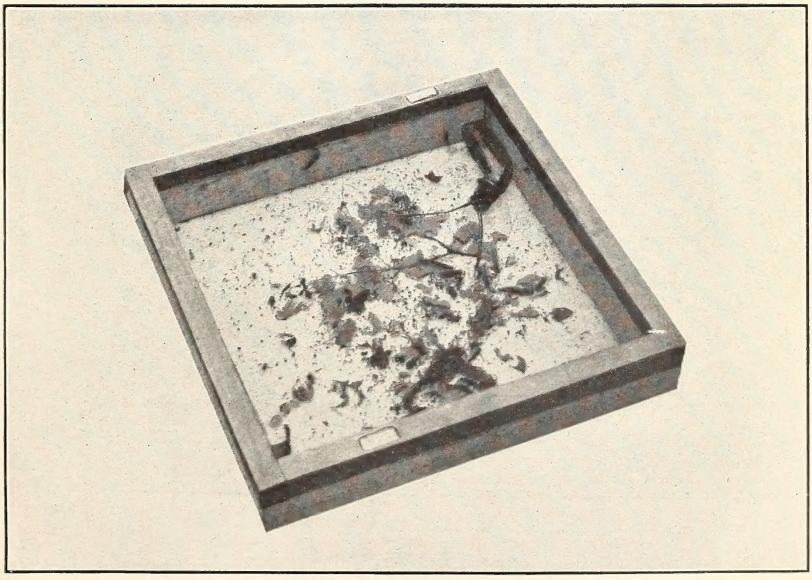
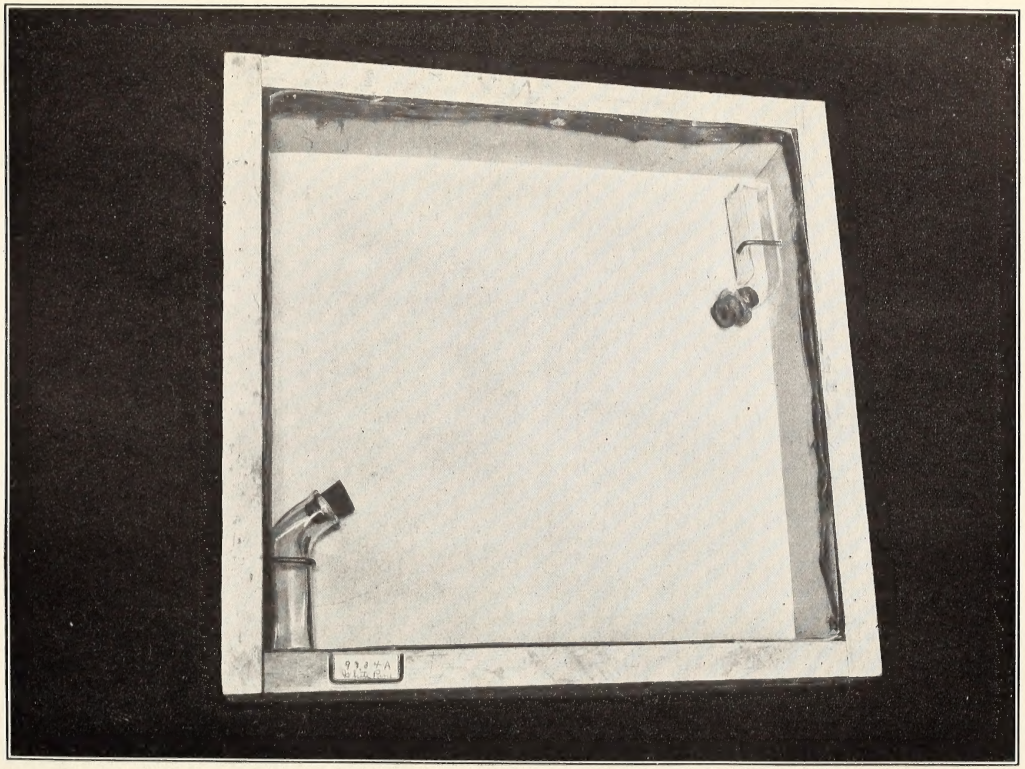


FIG. 2.—TRAY USED FOR FEEDING GIPSY-MOTH CATERPILLARS.

Note that this tray has a cloth bottom, a band of tanglefoot near the top, and is supplied with a bottle of water into which the sprig of foliage is inserted. (Original.)

GIPSY-MOTH LARVÆ AND IMPROVED FEEDING TRAY.



IMPROVED TRAY USED FOR FEEDING GIPSY-MOTH CATERPILLARS.

Note that the bottom and sides are made of one piece of heavy paper which has been treated with paraffin. (Original.)

ously throughout the feeding season. It required the services of five assistants to attend properly to the feeding work and to record the necessary data. In addition, two assistants were employed to collect the food plants that were used in these experiments. Some of the species could not be secured in Melrose, and in a number of cases considerable travel was necessary in order to supply the foliage for the tests. During the summer of 1914 an assistant provided with a motorcycle was able to collect most of the foliage.

About the same number of assistants was required to conduct the experiments at the sublaboratory at Worcester, Mass., during the summers of 1912 and 1913.

A few tests or field observations were made on European trees and shrubs which occur in New England, but no effort has been made in this report to consider the food plants of the gipsy moth in Europe.

DIFFICULTIES IN CONDUCTING THE EXPERIMENTS.

As a result of previous experience in feeding caterpillars, it seemed necessary to secure a better method than simply placing leaves or twigs with foliage in the trays. When this is done the leaves wither rapidly in warm weather and often become so dry that it is extremely difficult to find all the first-stage caterpillars when the trays are cleaned. The use of the bottles of water in the trays obviated this trouble to a great extent and made the cleaning of the trays relatively easy. There were several kinds of foliage, such as linden, sassafras, and young growth of hickory, walnut, etc., that wilted rapidly in spite of every precaution that was taken.

In most of the trays a considerable number of caterpillars died from the disease known as "wilt," and in a few cases the imported parasites produced heavy mortality among the gipsy-moth larvæ. These factors operated in varying degrees during different seasons, but had an important bearing on the number of larvæ that survived the tests.

FOOD PLANTS TESTED.[1]

NOTE.—The writer expresses his appreciation to all who have assisted in these experiments. Special thanks are due to the Board of Park Commissioners of Worcester for the use of the sublaboratory in their city and to Mr. A. V. Parker, superintendent of parks, and Mr. H. L. Neale, city forester, for many courtesies extended; to Dr. C. S. Sargent and his assistants for permission to secure foliage at the Arnold Arboretum for some of the experiments; and to Mr. H. A. Preston for preparing the photographs illustrating this report, as well as to the many other employees of the Gipsy Moth Laboratory who have contributed toward the data summarized in this report.

[1] The botanical designations, both scientific and common names, herein cited are verified by Britton and Brown, Illustrated Flora of the Northern States and Canada. Second Edition, Vols. I–III, New York, 1913.

In the following pages are given a brief statement of the results secured with each food plant tested. Field observations are also included to make the data as reliable as possible. Experience has shown that results, even with the same food plant, vary to some extent during different years; and as the information is based upon three years' work, it is believed that this variability has been given due consideration.

It should be remembered that in the trays the larvæ were furnished with the same species of foliage during the entire season, hence the results are not exactly the same as would be secured under field conditions where a variety of food is usually available. A certain amount of injury to caterpillars always results from handling them in trays, so that the rate of reproduction in the experiments is in all cases less than under field conditions.

Alder, Speckled (*Alnus incana* [L.] Willd.).

In the tray experiments the larvæ fed freely in all stages. The growth and reproduction were normal. The field observers agree that gipsy-moth larvæ usually feed in all stages on this plant, but in the first three stages it seems to be preferred. As alder is of little commercial value it should be removed when cuttings are being made. (Pl. III, fig. 2.)

Apple (*Pyrus malus* L.).

This species was found to be a favorite food of gipsy-moth larvæ both in the field and in the trays. In combination with other growth it is usually the most heavily infested.

Old trees of this species that have been neglected nearly always contain holes and crevices in which the gipsy-moth larvæ hide and go through their transformations, the females depositing their eggs where it is difficult to find them. These trees are a menace to the surrounding growth and should be removed.

Arbor Vitæ (*Thuja occidentalis* L.).

No observations were made on this species in the field, but it has been thoroughly tested in the laboratory. No reproduction was secured until experiments were carried on with third-stage larvæ. The feeding was slight and development was slow and imperfect. It is an unfavored food.

This species can be left in a stand of trees without fear of injury by the gipsy moth.

Black Ash (*Fraxinus nigra* [Marsh.]).

One adult male was reared from 100 larvæ started in the third stage. Many other tests were less favorable to the insect. Mr. T. J. Kennedy, one of the field observers, reports no feeding on this species of ash in southern New Hampshire. It is an unfavored species.

Blue Ash (*Fraxinus quadrangulata* Michx.).

A single specimen of this tree was under observation. It was located in Elm Park, Worcester, and foliage was tested in the trays in the Worcester laboratory by Mr. Collins in 1912.

Although larvæ from the first to the fifth stages, inclusive, were tried, none reached the adult stage. It is an unfavored species.

Mountain Ash (*Pyrus americana* [Marsh.] D.C.).

No observations were made on this species by the field men.

Tray experiments for a single season at Worcester were not conclusive, but the results at Melrose Highlands indicated that larvæ will feed continuously on this plant from the first stage and reproduce normally.

Red Ash (*Fraxinus pennsylvanica* Marsh.).

But few field observations were obtained on this species, and those were to the effect that gipsy-moth larvæ do not feed on red ash.

All larval stages from the first to the fourth, inclusive, were tested at the Melrose Highlands laboratory, but no pupæ were obtained.

When the blossoms were placed with the foliage in the trays, there was considerable feeding on the former but the leaves were not injured.

White Ash (*Fraxinus americana* L.).

This most common species of Fraxinus has been noted by all the field observers, but none reported feeding on the foliage by gipsy-moth larvæ except where other species of trees are nearly or wholly defoliated. Even then there was little feeding in most cases. Mr. Proctor reports that branches on several trees of this species were completely stripped in an area badly defoliated by the gipsy moth.

White ash was tested in 1912 both at Worcester and Melrose Highlands. At the former laboratory, the larvæ from the first to the fifth stages, inclusive, produced no pupæ. At Melrose Highlands trays started with fourth-stage larvæ produced male moths only.

Flame Azalea (*Azalea lutea* L.) and White Azalea (*Azalea viscosa* L.).

Mr. Schaffner had the former species under observation and found that wherever it was situated in badly infested localities feeding on the foliage was rather heavy. This foliage will probably sustain the gipsy-moth larvæ in all stages, but the tray work at Melrose Highlands failed to bring them through from either the first or second stages. From two trays started with third-stage larvæ, male moths were secured.

There was practically no difference in the amount of feeding on these two species.

European Barberry (*Berberis vulgaris* L.).

Barberry has been under observation in the field, and all the observers have found gipsy-moth larvæ in all stages feeding upon it. It is not considered a particularly favored food, as larvæ feeding upon it seemed quite susceptible to disease.

The species will support the larvæ in all stages, adults having been reared from trays started with first-stage caterpillars.

Bayberry (*Myrica carolinensis* Mill.).

In sparsely infested territory, feeding on this species is light, but when the infestation is heavy these shrubs are sometimes completely defoliated.

Reproduction has been satisfactory when small caterpillars have been tested in the trays.

American Beech (*Fagus grandifolia* Ehrh.).

Field observers all agree that gipsy-moth larvæ feed heavily on this species during the first three stages, after which they migrate to other species and usually return to do considerable feeding during the last, or, in some cases, a part of the last two stages. Tray experiments verified this, for in the first three stages there was heavy feeding on the foliage, whereas in the fourth stage there was much less feeding and larval growth was retarded. These caterpillars were restless and appeared to be searching for different food. They died before reaching full growth.

It is evident that the beech must be associated in a mixture with one or more favored species in order that the gipsy moth may reproduce normally.

Black Birch (*Betula lenta* L.).

Field observations indicate that feeding on the black birch is somewhat variable, and it is seldom severely defoliated except in grossly infested areas.

The results secured from the tray experiments were also variable, and while it is possible for larvæ in all stages to survive on this foliage, they usually do not grow as rapidly or develop as vigorous individuals as when supplied with more favored food.

Apparently this tree comes near the line of favored and unfavored species.

Gray Birch (*Betula populifolia* Marsh.).

This species is more generally distributed than any other in the area infested by the gipsy moth.

All the observers agree that the larvæ feed on this birch through all stages and grow large and rapidly except, possibly, in the first stage. Reproduction of the moth on this tree is usually heavy.

In the laboratories the larvæ grew rapidly after the first stage and produced many moths.

One peculiarity was observed in the feeding of the larvæ; both at Worcester and Melrose Highlands the young larvæ fed almost wholly on the petioles of the leaves, severing them from the blades.

Several cases have been observed in the field where the bark on the tender twigs has been completely girdled by the larger larvæ.

This is one of the most favored food plants of the gipsy moth.

Paper Birch (*Betula papyrifera* Marsh.).

This birch is found quite plentifully in the higher altitudes of the gipsy-moth infestation, but in the low altitudes the species is represented by only a few widely scattered specimens.

In the field the larvæ feed on this tree in all stages, and total defoliation results if the infestation is sufficiently great. (Pl. III, fig. 1.)

In the tray work this species proved a very favored food. From one tray of first-stage larvæ at the Worcester laboratory, Mr. Wooldridge obtained 25 egg masses. Heavy reproduction was also obtained at the Melrose laboratory.

Red Birch (*Betula nigra* L.).

This species occurs in a few localities in New England. Mr. Proctor, who had trees under observation in the Merrimac Valley, reports feeding in all stages and defoliation toward the end of the season.

FIG. 1.—PAPER BIRCH FOLIAGE SHOWING PINHOLE FEEDING. (ORIGINAL.)

FIG. 2.—SPRECKLED ALDER FOLIAGE SHOWING SHOT-HOLE FEEDING. (ORIGINAL.)

TWO FOOD PLANTS OF THE GIPSY-MOTH LARVÆ.

WORK OF GIPSY-MOTH LARVÆ IN CRANBERRY.

a, Old growth at base, spring growth, buds, and blossoms near tip; *b*, vines showing where new growth has been cut off by gipsy-moth larvæ; *c*, new growth that has been cut off by gipsy-moth larvæ. Note that little feeding has taken place on the old growth. (Original.)

The tray experiments were not satisfactory because of the difficulty of securing a satisfactory food supply, but all the larvæ grew well in the early stages. Red birch is a favored food plant.

Yellow Birch (*Betula lutea* Michx. f.).

Except in heavy infestations, most of the feeding on this species by gipsy-moth larvæ is done in the first three stages. The larvæ make small holes, extending entirely through the leaves, forming "pinholes," and a few days later "shot holes." If the infestation is bad and the associated species of food plants are defoliated, these birches are sometimes stripped.

In tray experiments male moths have been secured by feeding larvæ started in the first stage.

High Blackberry (*Rubus* sp.).

Field observations indicate considerable variation in feeding on this plant. Defoliation has seldom been reported, and then only when heavy infestations occurred. Under ordinary conditions the feeding on this species is very slight.

Low Blueberry (*Vaccinium vacillans* Kalm.).

Of the three species of Vaccinium under observation in this series of experiments, this is the most unfavorable. Larvæ in the field have been found feeding in all stages, but not to any extent, except in medium to grossly infested territory. Usually the last three stages do most of the feeding on these shrubs.

First-stage caterpillars fed in trays have produced moths, which indicated that the insect can survive on this species.

Tall Blueberry (*Vaccinium corymbosum* L.).

All the field observers consider *V. corymbosum* more susceptible to gipsy-moth attack than *V. vacillans*, but it is not favored when other food is available. When an infestation is fairly heavy it is not uncommon for these shrubs to be entirely denuded.

First-stage caterpillars have developed to the adult stage when fed in trays. The larvæ did not grow as rapidly as is normal and were undersize.

Blueberry (*Vaccinium angustifolium* Ait.).

The field observers pronounce this species the most susceptible to moth attack of our three common species. They note feeding in the early as well as the late stages, and the shrubs may be found in all stages of defoliation. When a tree has been completely defoliated by the larvæ and they migrate to another tree, these shrubs furnish food for the journey.

First-stage larvæ fed in trays grew rapidly and large vigorous adults resulted.

Box Elder (*Acer negundo* L.).

No field observations are recorded on this species.

Tray experiments indicate that this is one of the most susceptible of the maples to moth attack. The larvæ fed freely in all stages and grew to large size; specimens started in the first stage produced moths.

GREENBRIER (*Smilax rotundifolia* L.).

No experiments were conducted on this species at the laboratory.

Observations in the field indicate that this species is seldom attacked.

SWEETBRIER (*Rosa rubiginosa* L.).

Mr. Schaffner found larvæ in the first four stages feeding to a slight extent on this foliage.

No tray experiments were conducted. It is an unfavored plant.

BUTTERNUT (*Juglans cinerea* L.).

In a single instance stripping of this species has been recorded. Mr. Proctor observed this at North Andover, Mass. Other reports indicate very light feeding.

In trays at Melrose Highlands and Worcester males were reared from 100 second-stage larvæ. The caterpillars fed very sparingly and grew slowly. This is an unfavored food plant.

HARDY CATALPA (*Catalpa speciosa* Warder).

No observations were made on this species in the field.

In the Melrose Highland laboratory the larvæ started in the first stage all died before molting. Each succeeding stage was tried, and a few lived long enough to molt once before dying. No adults were obtained. A very unfavored species.

RED CEDAR (*Juniperus virginiana* L.).

This tree is seldom eaten to any appreciable extent by gipsy-moth larvæ, and only in the worst infestations do they show the least feeding on the new growth. It is a common occurrence at the end of the larval season to find trees heavily infested, due to the larvæ having sought shelter from the hot July sun.

Trays were started with this cedar at the Melrose Highlands laboratory, using each succeeding stage of the larvæ from the first to the fifth, inclusive. No moths were produced as a result of feeding on this plant.

SOUTHERN WHITE CEDAR (*Chamæcyparis thyoides* [L.] B.S.P.).

Mr. Schaffner reports considerable feeding on these trees each year, and in 1913 it amounted to 75 per cent defoliation.

Tray records indicate that it is an unfavored species, although one male moth was obtained from 100 fourth-stage larvæ. It is probable that solid stands of this species will not be injured.

WINTERGREEN (*Gaultheria procumbens* L.).

Mr. Shinkwin notes feeding on the leaves of this plant by gipsy-moth larvæ, and in rare instances there was considerable eating of the fruit.

No tray experiments have been carried on with this species. It is unfavored food.

CHOKE CHERRY (*Padus nana* (Du Roi) Roemer).

This species is found as an undershrub in many wood lots. Very little feeding has been noted by any of the observers, and that was done almost wholly by the first three stages, the small larvæ making pinholes in the leaves.

In the trays, both at Melrose Highlands and Worcester, adults were reared. The larvæ thrived about the same as on wild red cherry and were of fair size. This species appears to be the most favored of the cherries.

Sweet Cherry (*Prunus avium* L.).

Trays started with newly hatched larvæ, both at the Worcester and Melrose Highlands laboratories, produced moths. The larvæ fed very slowly, especially in the later stages, and were of small size.

Mr. Shinkwin observed a single roadside tree in a badly infested area that was nearly defoliated by third and fourth stage larvæ.

Wild Black Cherry (*Prunus serotina* Ehrh.).

Adults were obtained from first-stage larvæ started in trays. These larvæ grew very slowly and were only about one-half normal size.

From all sections the observation is made that there is little feeding and by all stages. Mr. Shinkwin notes a case in a heavy infestation where wild black cherry was nearly defoliated.

Wild Red Cherry (*Padus virginiana* (L.) Mill.).

This cherry was fed upon very slightly by the gipsy-moth larvæ, usually in the first two stages and very slightly in the third. The blossoms were attacked more than the leaves.

In the trays at Melrose Highlands adults were secured from first-stage larvæ. They fed sparingly and grew very slowly.

Chestnut (*Castanea dentata* [Marsh.] Borkh.).

This species has been observed by all the field men, and they agree that gipsy-moth larvæ feed upon it to a limited extent in all stages except the first. If favored food plants are abundant, the larvæ soon confine their attention to these plants. Where the infestation is heavy and the favored food is consumed the chestnuts are sometimes stripped.

In the tray work at both laboratories no first-stage larvæ started on this foliage went through to the second stage. Second-stage larvæ fed and adults were secured.

Chokeberry (*Aronia melanocarpa* [Michx.] Britton).

First-stage larvæ fed freely on this species in the trays and produced adults. A small amount of feeding was noted in the field, mainly on the blossoms.

Cornus (*Cornus* sp.).

Mr. Proctor notes pinhole feeding on this species in the field, but the other observers do not record any feeding in the other sections.

In the trays none reached the adult stage, although tried with the different stages of the larvæ. It is an unfavored species.

Flowering Dogwood (*Cynoxylon floridum* [L.] Raf.).

This species was tried in the laboratory at Melrose Highlands with each successive stage of gipsy-moth larvæ and none reached the adult. More feeding was noted on the flowers than on the leaves. In the field, even in badly infested territory, only very slight feeding was noted. It is an unfavored species.

RED OSIER (*Cornus stolonifera* Michx.).

In heavily infested territory some of the field observers have found slight feeding during the early part of the year. This did not extend beyond small holes in the leaves and notches in the edges.

In the laboratory each successive larval stage was tried on the foliage and no adults were obtained.

COTTONWOOD (*Populus deltoides* Marsh.).

Cottonwood is seldom found in this section, but was tried in the trays in order to know whether it is favored in case the moth spread to territory where this species is common.

About 10 per cent of the first-stage larvæ started on this foliage carried through to the second stage, when they all died. At least 10 per cent of the third-stage larvæ started in trays reached the fifth stage, but no adults were obtained. In the early stages the feeding was slight and growth accordingly slow, but in the later stages feeding was more free and growth more rapid.

No observations were made on this species in the field.

AMERICAN CRANBERRY (*Oxycoccus macrocarpus* [Ait.] Pursh).

The larvæ eat but little of the foliage of the cranberry vines, but cut off the stems just above the old growth and also the stems of the flowers or newly set berries. (Pl. IV.) The habit of the larvæ is to feed at night and remain secreted during the day. By parting away the vines the larvæ may be found underneath, next to the cool earth, ready to come up when the sun goes down to continue the feeding. Bogs that appear to be entirely free of the pest may harbor great numbers that will greatly reduce the crop.

In the trays we failed to obtain adults from larvæ started in the first stage on this foliage. On the bogs, however, was evidence that larvæ hatched on the vines had come through to the adult stage without other food.

RED CURRANT (*Ribes vulgare* Lam.).

Tray experiments failed to produce any adults, although the different stages were fed upon the foliage. In the early stages there was more feeding according to size of larvæ than in the later stages, and the larvæ lived longer.

Mr. Schaffner noted very slight feeding on this species in the field. It is an unfavored food plant.

BALD CYPRESS (*Taxodium distichum* (L.) Rich.).

Bald cypress was tried with all larval stages in the trays and only a very small percentage went through to the next stage. None reached the adult stage. Feeding was very slight and there was practically no growth. It is an unfavored species.

DANGLEBERRY (*Gaylussacia frondosa* (L.) T. & G.).

Larvæ in the third stage started on this foliage reached the sixth stage. No pupæ were obtained from any stage.

Mr. Schaffner made observations on this undershrub in the field and in one instance notes a defoliation of 50 per cent, but as a rule there is but slight feeding.

BUSH HONEYSUCKLE (*Diervilla diervilla* [L.] MacM.).

This is a very common shrub along roadsides and in waste places. Mr. H. W. Allen reports that it was not eaten in an infested area at Manchester, N. H. It is an unfavored species.

NARROW DOCK (*Rumex crispus* L.).

Mr. Bailey reports seeing first and second stage larvæ feeding on this dock in Pelham, N. H. But little feeding was noted, however. It is an unfavored species.

AMERICAN ELDER (*Sambucus canadensis* L.).

This foliage was used in trays for all stages of gypsy-moth larvæ up to and including the fourth stage, and but very few changed to the next stage. There was very slight feeding and no growth.

Several observers have seen larvæ on this species, but none note any feeding beyond a few pinholes or notches in edges of the leaves. It is an unfavored species.

AMERICAN ELM (*Ulmus americana* L.).

All stages of the larvæ were noted feeding on elm, but usually to a limited extent. In heavily infested areas, where other species are completely defoliated, the elm shows much feeding, but it does not appear to be a favorite food if other species are available. In the trays, adults were reared from larvæ started in the first stage on elm foliage. The growth, however, was slow and the feeding light.

The preference for this food seems to have changed in the last 20 years. In the early nineties the elms were considered favored food. In the spring and summer of 1894 elm was the food used in nearly all the experiments carried on in the Massachusetts State Laboratory, then located in Malden, Mass. The larvæ fed freely on it and grew rapidly. In the trays in 1912 it was apparently distasteful to them and they were constantly searching for other food.

ENGLISH ELM (*Ulmus campestris* L.).

Our only knowledge on this elm is from the tray experiments. The larvæ fed about the same on this species as on the native elm, but none reached the adult stage. A few reached the fifth stage that were started in the third stage. In the open they could probably develop from the egg to the adult.

SLIPPERY ELM (*Ulmus fulva* Michx.).

Tray experiments show this to be an unfavored food plant. Few larvæ passed to the next higher stage while being fed upon it.

Mr. Proctor notes slight feeding in the field in all stages where the infestation was heavy.

SWEET FERN (*Comptonia peregrina* [L.] Coulter).

Larvæ in all stages have been observed feeding on this shrub and in heavily infested localities defoliation has taken place. In spite of this evidence it is not a favored food, and if other species are present in considerable numbers the feeding is not usually heavy on sweet fern.

Tray experiments show slow feeding and very little growth. But few larvæ passed to the next higher stage.

SPICE-BUSH (*Benzoin aestivale* [L.] Nees).

No field observations have been made on this rather common shrub.

In the trays the larvæ in all stages seemed to dislike the food and there was little or no growth. Death resulted in a short time from starvation and disease.

BALSAM FIR (*Abies balsamea* [L.] Mill.).

Mr. Gooch has had this species under observation. On July 14, 1914, he found in a mixed growth which was nearly defoliated heavy feeding on this species by fifth and sixth stage larvæ. A few small trees were 75 per cent defoliated. No feeding was observed by earlier stages.

In the trays little feeding took place before the third stage, and then the larvæ began to die rapidly and no adults were reared. This is an unfavored species.

SWEET GALE (*Myrica gale* L.).

Foliage from this species used in two trays with newly hatched larvæ produced adult moths. This shows it to be a favored food plant, as the larvæ fed freely in all stages.

Mr. P. S. Coffin found fourth and fifth stage larvæ feeding freely on sweet gale in Candia, N. H. None of the other stages have been observed feeding upon it in the field.

GRAPE (*Vitis labrusca* L.).

Tray experiments with the foliage of wild grape with each stage of the larva shows that the latter will die before reaching the next stage. There was very little feeding, which consisted of small notches being made in the edges of the leaves.

Mr. Schaffner made observations on this plant in the field which agree with the results secured in the laboratory.

HACKBERRY (*Celtis occidentalis* L.).

Newly hatched larvæ started on this foliage reached the fifth stage before the last one died. They did not appear to care for the food and grew very slowly.

Mr. Schaffner watched one tree of this species, but found no feeding at any time upon it.

PINK HARDHACK (*Spiræa tomentosa* L.).

All stages of the larvæ have been observed on this species in the field and slight feeding has been reported, but the foliage will not sustain life through the different transformations.

Larvæ in the trays died before reaching the succeeding stage.

WHITE HARDHACK (*Spiræa salicifolia* L.).

Tray experiments and field observations show that this species is unfavorable, since larvæ are unable to develop sufficiently to transform to the next stage.

HAWTHORN (*Cratægus* sp.).

Field reports indicate that this species is freely eaten by the larvæ in all stages.

This species was tested in the Worcester laboratory and the larvæ fed freely in all stages, grew well and went through from first stage to adult. It is a favored food plant.

Hazelnut (*Corylus americana* Walt.).

This is a favored food plant for all stages of the larvæ, although feeding is heavier during the first four stages.

In the laboratories the feeding in trays was general in all stages and male and female moths were reared from larvæ started in the first stage.

Beaked Hazelnut (*Corylus rostrata* Ait.).

Not as common as the above species. Field observations same as for *C. americana*.

Laboratory experiments had to be discontinued after the larvæ reached the third stage because the shrubs were sprayed with poison.

Hemlock (*Tsuga canadensis* [L.] Carr.)

This evergreen is capable of supporting life in all stages of the gipsy-moth larvæ. At the Worcester laboratory, Mr. Collins reared 2 males and 1 female from the two trays of first-stage caterpillars. At the Melrose Highlands laboratory no adults were reared.

The field observers note feeding in all stages on the foliage, but in the first stage it is the new growth only. The feeding increases in intensity with each successive stage. In the field few adults develop when this tree is the exclusive diet of the gipsy-moth larvæ. (Pl. V.)

Bitternut Hickory (*Hicoria cordiformis* [Wang.] Britton).

No field observations were made on this hickory.

In the trays the larvæ fed quite freely in the first three stages, but the foliage appeared somewhat distasteful to them in all stages.

The tree will doubtless sustain the caterpillars through life, but is not a favored food plant.

Mockernut Hickory (*Hicoria alba* [L.] Britton).

This seems to be the most favored species of the hickories. Mr. Shinkwin reports nearly total defoliation of a few trees. Feeding is most noticeable in the early stages.

In the trays, first-stage larvæ were reared to the fifth stage only.

In heavy infestations, in a mixed growth, this tree may be severely defoliated.

Pignut Hickory (*Hicoria glabra* [Mill.] Britton).

Pignut hickory has been watched by all the observers and slight feeding upon it has been noted in all stages. All are of the opinion that it is an unfavorable food plant. The first-stage larvæ begin feeding upon the bud scales and follow up by eating holes in the new unfolding leaves.

In the trays at Melrose Highlands started with first-stage larvæ, male moths were obtained. At no time was the feeding free, and growth was very slow.

Shagbark Hickory (*Hicoria ovata* [Mill.] Britton).

Shagbark hickory is eaten by the gipsy-moth larvæ less than the other hickories. The field observers report considerable feeding on the bud scales and after these drop the feeding diminishes. All stages have been reported feeding upon it sparingly.

In the trays, both at Worcester and Melrose Highlands, larvæ started in the first stage died on or before reaching the third stage.

American Hornbeam (*Carpinus caroliniana* Walt.).

All larval stages feed upon this foliage, and defoliation results in badly infested territory.

This species was tried in both laboratories, and first-stage larvæ died on or before reaching the third stage.

Hop Hornbeam (*Ostrya virginiana* [Mill.] Willd.).

In the tray experiments at Melrose Highlands and Worcester first-stage larvæ failed to develop beyond the third stage on this foliage.

Larvæ feed on this foliage in all stages in the field.

Highbush Huckleberry (*Gaylussacia baccata* [Wang.] Koch).

This is an unfavored food plant and will not sustain the larvæ until they are full grown. The observers report seeing the larvæ in all stages feeding upon this species; in most cases they were probably larvæ that had spun down from overhanging trees.

In the trays a few male moths were obtained from larvæ started in the second stage.

Inkberry (*Ilex glabra* [L.] A. Gray).

In southeastern Massachusetts this species is common over large areas.

Tray experiments and field observations both show that the larvæ can not subsist upon it.

Smooth Winterberry (*Ilex lævigata* [Pursh] A. Gray).

Larvæ have been reported on this species in all stages eating small holes or notches in the leaves. These were probably larvæ that had been shaken down from overhanging trees or had crawled from near-by species. None seemed to stay for extended feeding.

In the trays there was very slight feeding and no growth. The caterpillars died rapidly of starvation.

American White Holly (*Ilex opaca* Ait.).

Mr. Schaffner reports finding larvæ in the third, fourth, and fifth stages feeding slowly on this species.

Larvæ in the trays fed sparingly in the first stage, but died rapidly of starvation. In the succeeding stages there was hardly any feeding, and death resulted.

Feverbush (*Ilex verticillata* [L.] A. Gray).

Tray experiments and field observations show that gipsy-moth larvæ will not subsist on this species. A few small notches in the leaves observed in the field and notches and small holes in the leaves in the trays constituted all the feeding. Larvæ died rapidly and did not grow at all.

Larger Blue-flag (*Iris versicolor* L.).

Mr. Kennedy found fourth and fifth stage larvæ feeding on this species in Hampton, N. H. The swamp was situated near a group of gray birches that were badly stripped: the larvæ were being blown off by the wind, and in searching for food crawled to these plants and partially defoliated them.

FIG. 1.—NORMAL HEMLOCK FOLIAGE, PHOTOGRAPHED JUNE 20, 1914. (ORIGINAL.)

FIG. 2.—HEMLOCK TWIG PARTLY DEFOLIATED BY FOURTH-STAGE GIPSY-MOTH LARVÆ; PHOTOGRAPHED JUNE 20, 1914.
This tree was stripped of foliage before midsummer. (Original.)

WORK OF GIPSY-MOTH LARVÆ IN HEMLOCK.

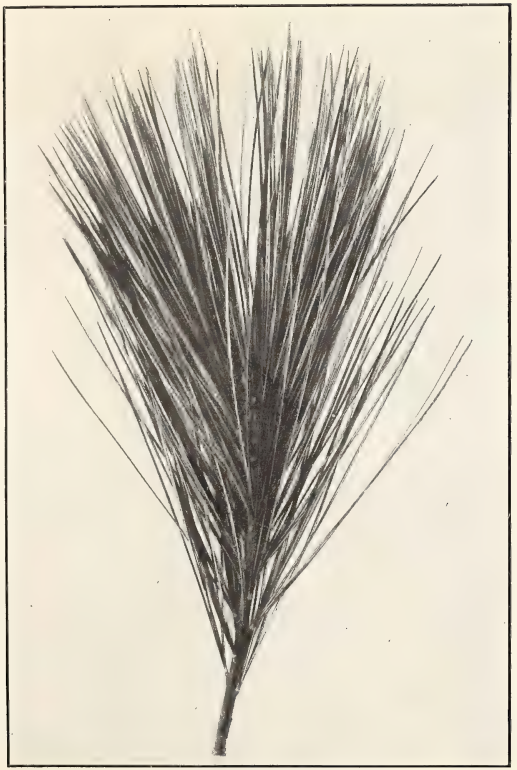


FIG. 1.—NORMAL WHITE-PINE FOLIAGE. (ORIGINAL.)

FIG. 2.—WHITE-PINE FOLIAGE BADLY INJURED BY GIPSY-MOTH LARVÆ.

Note the notches eaten in many of the needles.

WORK OF GIPSY-MOTH LARVÆ IN WHITE PINE.

Poison Ivy (*Toxicodendron radicans* [L.] Kuntze).

Feeding by all stages except the sixth has been noted upon poison ivy. This resulted in a number of notches and small holes being made in the leaves. It is not a favorable food plant.

Juniper, Common (*Juniperus communis* L.).

Many of the field observers have seen feeding by gipsy-moth larvæ on this species in all stages, usually on the new growth.

Laboratory work shows that this species will not maintain this insect through the larval stage.

Kentucky Coffee-tree (*Gymnocladus dioica* [L.] Koch).

This species was tested at Worcester and also at the Melrose Highlands laboratories. In the first stage, before the bud scales dropped, there was considerable feeding. Later there was practically no feeding in any of the stages.

No field observations have been made on this species.

American Larch (*Larix laricina* [Du Roi] Koch).

Tray experiments show this to be a favored food for the gipsy-moth larvæ. They fed freely in all stages and grew rapidly and to large size. They were, however, badly attacked by disease, but adults were secured from experiments begun with first-stage caterpillars.

No field observations were made on this species.

European Larch (*Larix decidua* Mill.).

Mr. Proctor notes feeding by first-stage larvæ on this species and in a diminishing degree in the second and third stages, after which no more feeding was noted. Observations were made in only one locality, and the species was not tested in the trays in the laboratory.

Mountain Laurel (*Kalmia latifolia* L.).

Tray experiments show that this laurel will not support life of the gipsy-moth larvæ, as they would not feed upon it to any extent and die rapidly from starvation.

Two observers have seen slight feeding on this shrub by first, fourth, and fifth stage larvæ, the two latter stages working on the blossoms as well as the leaves.

Sheep Laurel (*Kalmia angustifolia* L.).

Field observations and tray experiments show that this species is distasteful to the caterpillars, as they eat only when no other food is available and then to a very limited extent. In the trays the larvæ died rapidly when furnished with no other food.

Swamp Eubotrys (*Eubotrys racemosa* [L.] Nutt.).

Considerable feeding by all larval stages has been observed by Mr. Schaffner on this species in Middleboro.

In the trays it does not appear a very favorable food and no pupæ were obtained, as all larvæ died of disease and starvation.

American Linden (*Tilia americana* L.).

All field observers agree in calling this a favorable food for the gipsy-moth larvæ. It is eaten freely by all stages and is especially favored during the first three larval stages.

In the trays a fair percentage of adults were obtained from first-stage larvæ.

European Linden (*Tilia* sp.[1] L.).

Mr. Schaffner notes considerable feeding on this species by second and third stage larvæ.

In the trays this species did not seem to be as favored as the preceding one; the larvæ died rapidly and none pupated, although several reached the fifth stage.

Black Locust (*Robinia pseudoacacia* L.).

Slight feeding by all stages of the gipsy-moth larvæ has been observed in the field in mixed growth, where the infestation was bad.

In the trays the larvæ fed very sparingly and died rapidly. None before the third stage were carried to the adult stage, and all those reared were male moths. It is an unfavored species.

Honey Locust (*Gleditsia triacanthos* L.).

Results of the tray work show that this species ranks the same as the preceding.

No observations have been made in the field on honey locust.

Pepper-bush (*Xolisma ligustrina* [L.] Britton).

Slight feeding by gipsy-moth larvæ in all stages has been observed on this species in the field.

In the trays, feeding was very slow and little or no growth resulted. It is an unfavored species.

Mountain Maple (*Acer spicatum* Lam.).

No field observations have been made on this maple.

In the trays the first-stage larvæ fed freely, but after passing into the second stage feeding was much less, and none developed beyond the third stage.

Very little feeding occurred in the later stages and no adults were obtained.

Norway Maple (*Acer platanoides* L.).

Adults, both male and female, were obtained from the trays started with first-stage larvæ on this foliage. The larvæ fed freely, especially in the later stages, and grew to good size.

No field observations were made on this maple.

Norway maple and the box elder are the most favored species of the maples. They are not as freely eaten, however, as many other food plants.

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[1] *T. platyphyllos* and *T. vulgaris* are the lindens usually included by nurserymen as *T. europæa*, hence the designation *Tilia* sp. is adopted in the absence of specific determination.

Red Maple (*Acer rubrum* L.).

When this maple is mixed with other trees more favored by gipsy-moth larvæ and the infestation is light, the feeding in all stages is light. When the infestation is heavy and the other trees in the combination become defoliated, or nearly so, the feeding becomes more intense, and in some cases defoliation of this maple results. It is not, however, a favored food and will usually be deserted for other species.

In the laboratory, adults were obtained from trays started with first-stage larvæ on this foliage.

Silver Maple (*Acer saccharinum* L.).

In trays, first-stage larvæ did not develop and produce adults, as all the former died in the fourth or earlier stages.

No field observations were made on this species. This is not as favored a food as red maple.

Striped Maple (*Acer pennsylvanicum* L.).

Larvæ started on this foliage in any stage failed to reach the next stage. It is one of the most unfavored of the maples.

No feeding of any amount was observed in the field.

Sugar Maple (*Acer saccharum* Marsh.).

Very few observations on this species have been made in the field, but the observers are agreed that it is an unfavored food.

In the trays at Worcester and Melrose Highlands the first-stage larvæ grew fairly well and a few male and female moths were obtained. It is less favored than Norway maple and about as susceptible to attack as the red maple.

Red Mulberry (*Morus rubra* L.).

Mr. Collins tested this species in the laboratory at Worcester and found it an unfavorable food for the gipsy-moth larvæ. A few specimens passed into the following stage, but none lived through two stages of it. No field observations have been made.

White Mulberry (*Morus alba* L.).

White mulberry was tested in the trays at Melrose Highlands and about the same results were obtained as with the red species, except that it is slightly more favorable than the former. One male was reared from a tray started with second-stage larvæ.

No field observations were made on this species.

Black Oak (*Quercus velutina* Lam.).

The oaks are among the most-favored food of the gipsy-moth larvæ. The young larvæ begin feeding as soon as the buds are about half open. This is a favored species and is eaten freely by all stages of the caterpillars and produces large and vigorous adults.

Rock Chestnut Oak (*Quercus prinus* L.).

This species is not common in the infested area, but wherever found the observers were unanimous in their reports that it is very favorable food.

The same conclusions were drawn from the tray experiments. The larvæ fed freely in all stages, growth was rapid, and they attained large size. A good percentage reached the adult stage.

Dwarf Chestnut Oak (*Quercus prinoides* Willd.).

No observations were made on this species in the field.

The larvæ fed freely in the laboratory during the first two stages. It then became necessary to discontinue the experiments, as the specimen trees were sprayed. It is undoubtedly a favored food plant.

Bur Oak (*Quercus macrocarpa* Michx.).

Larvæ fed freely on this foliage in all stages and grew rapidly, but all died of disease by the time they reached the sixth stage.

No field observations were made on this species.

Pin Oak (*Quercus palustris* Du Roi).

Larvæ fed on this foliage freely in all stages in the trays, especially in the first stage, but none reached the adult stage on account of disease.

No field observations were made on this oak.

Post Oak (*Quercus stellata* Wang.).

Trays started with newly hatched larvæ on this foliage produced adult moths. Larvæ fed freely in all stages.

No field observations were made on this species.

Red Oak (*Quercus rubra* L.).

This is one of the most abundant oaks and the records of field observations are voluminous. All are agreed that the larvæ feed ravenously on it in all stages and that large vigorous larvæ are produced. This is usually one of the first species to be entirely defoliated in a mixed growth.

In the trays the larvæ fed freely in all stages and good reproduction resulted.

Scarlet Oak (*Quercus coccinea* Wang.).

In most of the infested territory this oak is found to some extent and all are agreed that it is eaten by larvæ in all stages, but usually not quite as freely as white, red, or black oak.

Tray work shows it to be a favorite food, as a good proportion of larvæ went through to the adult stage.

Bear Oak (*Quercus ilicifolia* Wang.).

As a food for gipsy-moth larvæ this is one of the most favored oaks. Not all the observers had this species in their divisions, but those that did agree as to the favorability.

In the tray work the same thing was shown, as the larvæ fed freely in all stages.

Shingle Oak (*Quercus imbricaria* Michx.).

This oak is a favored food for gipsy-moth larvæ, especially after the first stage. A good proportion of male and female moths were reared.

No field observations were made on this species.

Swamp White Oak (*Quercus bicolor* Willd.).

The feeding in the trays was not quite as free on this species as on some of the oaks, but a fair percentage of adults were reared.

The field observers do not all agree as to the favorability of the species, as some consider it the most favored oak, while others find that it is not preferred as much as other oaks.

White Oak (*Quercus alba* L.).

This species does not put out foliage until after the other oaks and other trees in the combinations have come into leaf. The larvæ feed on the swelling buds, and many desert this species for the red, black, and scarlet oaks. This accounts for the early stripping of the other species.

Tray work and field observations show that the white oak is probably the most favored food plant of the gipsy moth.

Osage Orange (*Toxylon pomiferum* [Raf.]).

Tray experiments with this species show it is not a favored food. No pupæ were obtained and but few larvæ reached the second stage.

No field observations were made.

Pear (*Pyrus communis* L.).

Pear foliage will sustain life in the gipsy-moth larvæ and carry them through to the adult, as shown by Mr. Collins's experiments at Worcester, but the larvæ and adults were very small and weak.

In the field but very little feeding has been noted on this foliage.

Persimmon (*Diospyros virginiana* L.).

This is not a favorable food plant, as but very few larvæ passed from one stage to the next stage, and growth was very slow.

No field observations.

Pitch Pine (*Pinus rigida* Mill.).

In the tray experiments no adults were obtained from larvæ started before the fourth stage, but from this stage both male and female moths were produced.

In the field the observers note feeding by the fourth, fifth, and sixth stage larvæ when pitch pine is growing with gray birch. The feeding is mostly confined to the old needles, the new growth seldom being attacked.

Red Pine (*Pinus resinosa* Ait.).

In the tray work with this species almost no feeding was observed until larvæ in the third stage were placed upon it. These, however, did not live beyond the fourth stage. The feeding was done by eating notches in the old needles.

In the field, larvæ were seen to feed upon red pine from the third to the sixth stages. In the last three stages they sometimes cause severe stripping.

Scotch Pine (*Pinus sylvestris* L.).

Tray experiments started with first-stage larvæ on this species failed to produce second-stage larvæ. Those started with second-stage produced sixth-stage larvæ, when many died from disease. The feeding was slow until the new growth expanded, after which they fed freely.

Mr. Proctor has noted practically the same thing in the field.

Gray Pine (*Pinus banksiana* Lamb.).

First-stage larvæ started on this foliage in the trays failed to go beyond the second stage. Trays started with larvæ in the third stage produced both male and female pupæ. Feeding was fairly free on the foliage after the first stage.

No field observations were made on this pine.

Western White Pine (*Pinus monticola* Dougl.).

First-stage larvæ supplied with this foliage failed to reach the second stage, but second-stage larvæ fed and a good number of male moths were produced. The feeding after the first stage was quite free, and this food seems to be more favored than the white pine.

No field observations were made on this pine.

White Pine (*Pinus strobus* L.).

Tray experiments show that first-stage larvæ can not feed to any extent upon the foliage and do not pass into the second stage. Mr. Collins succeeded in rearing adults from second-stage larvæ at Worcester on white pine.

In the field, where the pine is clear or in mixture with hemlock, feeding did not begin before the third or fourth stages. When the pine is mixed with gray birch or with any of the oaks, first and second stage larvæ were observed feeding to a slight extent.

The larva begins feeding near the base of the needle and eats through until the larger part falls to the ground. Other needles are attacked in the same way, so that a tree may be stripped in a very short time. (Pl. VI.)

Beach Plum (*Prunus maritima* Wang.).

Beach plum is not a particularly favored food plant. First-stage larvæ died before completing the third stage, and those started in the third stage produced male moths only. They fed but little, grew very slowly, and the pupæ were of small size.

Mr. Kennedy observed larvæ in the first, second, and third stages feeding upon this foliage to a slight extent in the field.

American Aspen (*Populus tremuloides* Michx.).

Although this species can not be placed in the class with oak, apple, willow, etc., in favorability, yet it will support the larvæ from time of hatching to pupation, and will produce fairly vigorous pupæ. The male moths developed from experiments when larvæ were started in the first stage.

Feeding was observed in the field by all stages, and in some cases complete defoliation resulted.

BALM-OF-GILEAD (*Populus balsamifera* L.).

In the trays the food withered badly, and although first-stage larvæ developed full-grown larvæ and moths they were undersized.

In the field the writer has observed very large sixth-stage larvæ feeding on this poplar, and large adults resulted.

LARGE-TOOTHED ASPEN (*Populus grandidentata* Michx.).

No adults were obtained from the trays started with first-stage larvæ on this species, as the last caterpillar died in the fifth stage. The larvæ fed freely up to the fourth stage, when feeding fell off and they died rapidly of disease.

In the field much the same observations were made, but the larvæ were exceptionally large and some moths were produced.

LOMBARDY POPLAR (*Populus nigra* var. *italica* Moench).

No adults were obtained from this species either at Worcester or at Melrose Highlands, but at the former laboratory larvæ in the fifth stage developed in trays started in the first stage. Feeding was quite free on this species, but the larvæ died rapidly of disease.

No field observations were made.

SILVER POPLAR (*Populus alba* L.)

Both at Worcester and Melrose Highlands the larvæ started in the first stage on this foliage all died by the time they reached the fifth stage. They fed quite freely, but died rapidly of disease.

This species is not favored by the gipsy moth as are the other poplars.

PRIVET (*Ligustrum vulgare* L.)

Very few larvæ started in any stage on this foliage reached the succeeding stage.

Mr. Schaffner reports slight feeding by second, third, and fourth stage larvæ. It is an unfavored species.

RASPBERRY (*Rubus* sp.).

Several observers have records of feeding on this plant. Most of these are of larvæ in the first stages. Complete defoliation occasionally results.

PASTURE ROSE (*Rosa virginiana* Mill.).

A large percentage of adults were reared from trays started with first-stage larvæ fed upon this foliage. Heavy feeding occurs in all stages.

Records of field observations show that the larvæ feed freely in all stages when the infestation is fairly heavy and stripping has been noted.

WILD SARSAPARILLA (*Aralia nudicaulis* L.).

Sarsaparilla is a plant which is very common in some localities. No feeding has been found on its foliage by the gipsy-moth larvæ.

SASSAFRAS (*Sassafras sassafras* [L.] Karst.).

A few male moths were produced in trays started with first-stage larvæ on this foliage. Feeding was fairly heavy in all stages. This foliage was very hard to keep in a fresh state and the trays had to be changed frequently.

Field observers have recorded feeding in all stages and in some instances defoliation.

SERVICE-BERRY (*Amelanchier canadensis* [L.] Medic.).

This is a very favorable food plant as the tray experiments and the observations in the field show. The trays produced a good percentage of males and females. The larvæ grew rapidly and were of large size.

Field observers record the feeding of the larvæ in all stages and in some cases a complete defoliation.

SKUNK CABBAGE (*Spathyema fœtida* [L.] Raf.).

Mr. Kennedy found fourth and fifth stage larvœ feeding upon this species, and they continued into the sixth stage. Many of the leaves were badly eaten.

BLACK SPRUCE (*Picea mariana* [Mill.] B.S.P.).

No field observations were made on this species.

In the trays, first-stage larvæ were reared to adults on this foliage. During the first stage, growth was very slow and many died of starvation, but in the second stage feeding increased and continued to increase with each successive stage. The larvæ in the last stages were large and fed ravenously.

NORWAY SPRUCE (*Picea abies* [L.] Karst.).

From trays started with third-stage larvæ, adult moths were reared. Larvæ in all the lower stages died before reaching the next stage. In the later stages feeding was rapid, but in the first three stages the larvæ fed very little and growth was very slow.

RED SPRUCE (*Picea rubens* Sargent).

Trays started with first-stage larvæ on this foliage did not produce second-stage larvæ; when started with second-stage, male moths were produced only. In the first stage no feeding could be found on the foliage, and in the next stages feeding and growth were slow. In the last stages, however, the larvæ fed ravenously and growth was much faster.

WHITE SPRUCE (*Picea canadensis* (Mill.) B.S.P.).

The second stage produced a small percentage of male moths, and no females with larvæ started in trays on this foliage. Those started in the first stage died before reaching the second stage. In the later stages feeding was fairly heavy and growth was rapid. It is about the same in favorability as red spruce.

MOUNTAIN SUMAC (*Rhus copallina* L.

This is one of the most favorable foods for all stages of the larvæ. A good percentage of males and females were reared from first-stage larvæ in the trays and growth was rapid.

All stages have been observed feeding upon it in the field, and defoliation has been noted repeatedly.

Scarlet Sumac (*Rhus glabra* L.)

This is another favorable species, and the larvæ grew to very large size. The first stage began feeding on the swelling buds by eating a small hole through the scales, and as the milky sap began to flow the larvæ fed upon it. They did not move about very much, but grew rapidly.

Feeding has been observed by all stages in the field.

Staghorn Sumac (*Rhus hirta* [L.] Sudw.).

This is not as favorable a species as the two foregoing. The larvæ do not grow as large. They will, however, develop from the first stage, but are badly attacked by disease.

All stages feed upon it in the field.

Red Gum (*Liquidambar styraciflua* L.).

This species ranks high as a favored food plant. Larvæ fed freely in all stages and grew rapidly. In the last two stages, however, they were badly affected by disease.

No field observations are available.

Sweet Pepperbush (*Clethra alnifolia* L.).

Field records show very slight feeding by all stages of the larvæ that have dropped from the overhanging trees, but they soon moved to other food.

In the trays no adults were obtained by starting any stage on this foliage until the fifth stage was reached, and then males were produced. It is a very unfavored food plant.

Sycamore (*Platanus occidentalis* L.).

Very few field records have been obtained on this species, although the second and third stages have been seen feeding very slightly on it.

In the trays the foliage was apparently very distasteful to them, and there was but little feeding and growth. Third-stage larvæ were reared to a few male moths. It is an unfavored species.

Tulip Tree (*Liriodendron tulipifera* L.).

Each successive stage was tried in the trays containing this foliage, both at Worcester and Melrose Highlands, but none reached the adult stage until experiments were begun with fifth-stage caterpillars. Scarcely any feeding was observed after the bud scales and blossoms dropped.

No field observations were made.

Black Gum (*Nyssa sylvatica* Marsh).

In the trays adults were reared from second-stage larvæ on this foliage, but all were males. In the first stage but very little feeding could be found on the leaves, and the larvæ did not reach the second stage.

In the field all stages were observed feeding upon the foliage, but no bad stripping was noted until the later stages.

Maple-leaved Arrowwood (*Viburnum acerifolium* L.).

This viburnum is not favored by the gipsy-moth larvæ in any stage, as shown by the field observations and the tray work.

In the trays none reached the adult stage, and nearly all the larvæ died in the stage in which the experiment was started.

In the field many larvæ in all stages were noted upon the foliage, having dropped from the overshadowing trees, but very little feeding was seen.

Arrowwood (*Viburnum dentatum* L.).

This foliage is somewhat more favorable as a food for gipsy-moth larvæ, as those started in the second stage reached the fifth stage, but no pupæ were obtained.

In the field but few observers had opportunity to obtain notes on this species. They have made record of slight feeding in nearly all stages.

Sweet Viburnum (*Viburnum lentago* L.).

The foliage of *lentago* is more readily eaten by gipsy-moth larvæ than the foregoing species. A few larvæ started in the early stages passed into the next stage, and male adults were obtained from trays started with fourth-stage larvæ. Growth was very slow and all were of small size.

No field observations were made on this species.

Cranberry Tree (*Viburnum opulus* L.).

Field observations show slight feeding by the larvæ in nearly all stages.

No tray experiments were conducted with this species.

Appalachian Tea (*Viburnum cassinoides* L.).

No pupæ were obtained from experiments with this species in the trays. The first-stage larvæ died after reaching the third and fourth stages, and the second-stage experiments were closed in the fifth and sixth stages.

In the field no feeding was observed except a few small notches in the leaves.

Black Walnut (*Juglans nigra* L.).

Tray experiments started with first-stage larvæ produced fifth-stage larvæ before they finally died. In the earlier stages very little feeding was done, but it increased considerably in the later stages. It is not a favorable food plant.

No field observations were made.

White Willow (*Salix alba* L.).

This is among the most-favored food plants for the gipsy-moth larvæ. In the trays a good number of adults of both sexes were obtained.

In the field all stages were observed feeding on the foliage, and large larvæ, adults, and egg masses were produced.

Glaucous Willow (*Salix discolor* Muhl.).

This species is also a favored food plant. In the trays a good number of adults were obtained from first-stage larvæ, which grew rapidly and were of large size.

No field observations were made.

Bay-leaved Willow (*Salix pentandra* L.).

From trays started with first-stage larvæ only fourth-stage larvæ were produced before they all died. No adults were obtained until fifth-stage larvæ were started. The foliage was rather distasteful to them and growth was slow.

No field observations were made on this species.

Sandbar Willow (*Salix interior* Rowlee).

Not as favored as the first two species, but more favored than the bay-leaved willow. Trays started with third-stage larvæ produced both male and female moths.

No field observations were made on this willow.

Witch-hazel (*Hamamelis virginiana* L.).

From the field came reports of the feeding of gipsy-moth larvæ in all stages upon this foliage, but probably more freely in the first stages.

In the trays, adults were reared from first-stage larvæ, which fed steadily in all stages.

The results given indicate in a general way the susceptibility of the species concerned to gipsy-moth attack.

There is in some cases, at least, considerable variation in susceptibility of different trees of the same species.

During the summer of 1912 foliage from two willow trees (*Salix alba* L.) were tested in trays at Melrose Highlands. They were growing side by side on lowland near a brook and both were in vigorous condition. First-stage gipsy-moth larvæ were placed in trays on the foliage of each tree.

Those supplied with the foliage of one tree fed normally, grew rapidly, and in due time developed into large adults. The other lot grew very slowly and the larvæ were very small and small adults developed. Nearly three times as many eggs were secured from the first lot as from the second. All the larvæ used in the experiment hatched from the same egg cluster.

In 1913 foliage from the same trees and larvæ hatched from the eggs of the previous year were used and the results were exactly reversed.

This indicates that there is variation in results with the same species of tree, but in this case it was not constant. A number of experiments along this line are contemplated.

COMBINATION-TRAY EXPERIMENTS.

Several series have been conducted to determine feeding preferences of gipsy-moth larvæ when two species of foliage were supplied in the same tray. In deciding the combination of species to be used it was thought best to place in the trays species that are usually found growing together in the field.

The results given below have been compared with the results with the same food plants growing in the open in so far as this data is available.

Speckled Alder and Willow.

Larvæ fed on both species, but appeared to prefer alder in all stages. After the foliage on alder was nearly all eaten the larvæ attacked the willow.

More adults were reared from these trays than from either alder or willow when fed alone. The larvæ grew steadily and attained large size.

In the field both alder and willow, when growing together, are defoliated if the infestation is heavy. The alder is usually stripped first.

American Beech and Chestnut.

Larvæ fed freely on the beech in the first two and last two stages. In the first stage there was no feeding on chestnut, and during the second stage the feeding was light, increasing to free in the third and fourth. After the fourth stage feeding decreased on chestnut. Preference for beech was noted except in third and fourth stages.

Larvæ grew to medium size and a fair percentage reached the adult stage.

American Beech and Red Oak.

Both of these foods were eaten freely throughout the experiment. Oak was a decided favorite in the first five stages. In the sixth stage feeding decreased, as the larvæ preferred the more tender leaves of the beech. The larvæ grew rapidly and were of large size. A good percentage reached the adult stage.

In the field the larvæ fed on the beech in the first two stages, then changed to the oak, where they fed until the last stage, when they returned to the beech.

American Beech and Sugar Maple.

Both these food plants were fed upon freely until the fifth stage, then moderately. A slight but continued decrease was noted on maple from the beginning of the fifth stage to the closing of the trays. Very little preference was observed in the first four stages.

A few larvæ reached the adult stage.

Black Birch and Witch Hazel.

There was no feeding on the birch during the first stage and but very little in the second and third. In the fourth and fifth stages the larvæ preferred the birch. The larvæ fed freely on witch hazel in the early stages. The caterpillars were small and reproduction resulted from this experiment.

Gray Birch and Chestnut.

There was no feeding on the chestnut during the first stage, but a steady increase was noted thereafter. Feeding was constant on the gray birch in all stages.

The larvæ grew slowly and were of small size and but few reached the adult stage.

Gray Birch and White Pine.

The larvæ fed freely in all stages on gray birch, but none at all on the pine in the first stage. The feeding on the latter species gradually increased until, in the last stages, they fed as well on this foliage as on the birch. They grew well and attained normal size and several reached the adult stage.

In the field in areas having this combination, the larvæ fed on the birch during the first three stages, when they attacked the pines. These were defoliated in many cases in the last three stages. The prevalence of wilt in the field often exerts a powerful influence in preventing complete defoliation of pine when it is grown in this combination.

Gray Birch and Red Spruce.

During the first stage all of the feeding was on the gray birch. There was a slight increase in feeding on the spruce in the later stages until the last two, when it diminished on the spruce.

The larvæ were rather small in size and grew slowly. A few reached the adult stage.

Paper Birch and Hemlock.

The larvæ fed freely on the paper birch in all stages. No feeding was noted on hemlock in the first stage, light in the second, and increasing during the third, and continuing moderate until the trays were closed. The larvæ showed a preference for birch in all stages, grew steadily to large size, and a large number of male and female moths developed.

Paper Birch and Sugar Maple.

The sugar maple in combination with this species is a favorable food. The larvæ fed upon it freely from the first to the fifth stages. During the fifth and sixth stages it was eaten more moderately. Birch was eaten freely at all times, although preferred in the later stages. Both species were eaten equally in the earlier stages.

The larvæ were of medium size and several reached the adult stage.

Paper Birch and Large-toothed Aspen.

Both of these foods are favorable. Except in the first stage, when the poplar was preferred, the larvæ fed with the same degree of freedom upon each. They grew steadily in the first stage, but more rapidly in the remaining stages, and attained average size. Several developed into adults.

Paper Birch and Red Spruce.

Larvæ fed freely on the birch in all stages, but did not feed on the spruce in the first stage. Feeding increased from the beginning of the second stage to the end of the fifth. Medium-sized larvæ resulted, from which several adults developed.

Paper Birch and Witch-hazel.

The larvæ fed freely on both food plants, with slight preference for witch-hazel until near the end of the experiment, when birch was eaten more freely.

Large larvæ resulted, from which several adults developed.

Yellow Birch and Hemlock.

Larvæ fed on the birch freely in the first four stages and more moderately in the latter stages. No feeding occurred on hemlock in the first and second stages. It was slight in the third and continued light in the remaining stages.

Larvæ grew rather slowly and were of small size and a few changed to adults.

Yellow Birch and Red Maple.

Larvæ fed more freely on birch than on maple, and the same proportionate feeding was maintained throughout the experiment. They were of small size and were badly attacked by disease. A small number reached the adult stage.

Yellow Birch and Sugar Maple.

The larvæ fed moderately on both food plants, with a slight preference for the birch at times. They grew slowly and were of moderate size. A few males and females were obtained.

Yellow Birch and Witch-hazel.

There was moderate feeding on both these food plants, but at times some preference was shown for witch-hazel. Growth was rather slow and the larvæ attained moderate size. A few males resulted.

Low Blueberry and White Pine.

This is the most unfavorable of the blueberries. Feeding was very light in the early stages and increased later, but at no time was this plant eaten freely. There was no feeding on pine in the first three stages. It was light in the fourth and increased in the later stages. Larvæ grew slowly in the early stages, but much more rapidly later, and reached medium size. Only males were obtained.

In a single location in the field the blueberry was very slightly eaten by first-stage larvæ, but no feeding was noted by the later stages. The infestation was light and no defoliation resulted to either the blueberry or pine.

Tall Blueberry and White Pine.

The feeding on blueberry by the first and second stage was light and there was great variation in the rapidity of growth. In the remaining stages feeding was free. Pine was not eaten in the first two stages. In the other stages it was fed upon slightly, but not freely. The larvæ grew quite rapidly and reached medium size. Adults of both sexes were obtained.

Blueberry and White Pine.

This blueberry is the most favored of the blueberries, and larvæ fed freely upon it in all stages. Pine was not eaten at all in the first two stages, but feeding increased in the later stages, when it was often eaten from choice. The larvæ grew rapidly and attained average size, and males and females developed.

Field reports show nearly complete stripping of the blueberry, but almost no injury being done to the pines.

Southern White Cedar and Red Maple.

Maple feeding was very light in the first stage; a gradual increase in the ensuing stages, which was never more than moderate. Cedar was not eaten in any stage even when the maple was in a withered condition. The growth of the larvæ varied greatly in this experiment.

In Middleboro, Mass., a large area in a swamp where these species predominate has been under observation for several years. During some seasons both the maples and the cedars have been defoliated, the latter by the large larvæ.

The small amount of undergrowth and the few other species of trees are unfavored food for gipsy-moth larvæ, and in this case practically all the feeding has been confined to the two species under discussion. This field record furnishes information which is quite contradictory to the laboratory experiments, although such evidence is exceptional.

American Hornbeam and Red Oak.

Feeding was continuous in all stages on the oak, but was very slight on the hornbeam in the first two stages, but later was much greater. A decided preference for oak was shown in all stages. The larvæ grew steadily and attained large size. A good percentage reached the adult stage.

Hophornbeam and Red Oak.

The larvæ fed freely in all stages on the oak, and the feeding increased from slight at the start to moderately free on hornbeam at the close of the experiment. Larvæ grew rapidly and attained large size and a good percentage reached the adult stage.

American Linden and Red Maple.

The larvæ fed moderately on the maple throughout the experiment. Linden feeding was moderate in the first stage, falling off slightly in the second and third, and moderate in the remaining stages. The larvæ were of good size and a fair percentage of adults was obtained.

Elm and White Pine.

None of the first-stage larvæ started on these food plants passed beyond the third stage. They fed only on the elm and were of very small size. Those started in the third stage produced male and female moths. They fed slowly on these foods, and grew accordingly.

In the field there has apparently been a steady decrease in the infestation, the pines being eaten by the large larvæ.

Hemlock and American Linden.

Larvæ fed freely on linden in all stages and very slightly on hemlock in the second stage. Feeding increased on the latter species in each successive stage. The larvæ attained moderate size, and a few adults were reared.

Hemlock and Sugar Maple.

There was no feeding on the hemlock during the first stage, but it increased gradually from the second to the sixth stage. Feeding was moderate on maple during the whole experiment. The larvæ reached medium size, and a few adults of both sexes were obtained.

Hemlock and Witch-hazel.

The larvæ fed freely in all stages on the witch-hazel, but none at all on the hemlock in the first stage; feeding increased gradually, and in the three last stages hemlock foliage was eaten freely.

The larvæ were of good size and produced both male and female moths.

Chestnut and Red Maple.

No feeding was apparent on the chestnut during the first and second stages, and it was moderate in the remaining stages. Feeding on maple was moderate in all stages. The larvæ were below average size, grew slowly, and only males developed.

In the field similar results have been observed.

Chestnut and Black Oak.

The larvæ fed freely on both food plants, except in the first stage, when they attacked oak exclusively. They grew steadily, attained large size, and adults were reared.

Field observations indicate that these species are freely eaten when growing in the same locality.

Chestnut and Chestnut Oak.

The oak was fed upon freely in all stages, but the chestnut was eaten moderately in all stages except the first. Growth was slow and the larvæ died before pupating.

Chestnut and White Pine.

Larvæ started in the first stage died in the third stage or earlier. Those that molted once were very small and puny, while those started in the third stage produced a few male moths. Both plants were eaten quite freely in the last stages.

Similar results have been noted in the field.

American Linden and Red Oak.

The larvæ fed lightly on the linden in the first few stages, and, although the feeding increased slightly in the later stages, it was never excessive. Oak was preferred and was eaten freely in all stages. The larvæ developed rapidly, were of average size, and several moths were reared.

In the field this combination furnishes very favorable food for the gipsy moth.

Red Maple and Witch-hazel.

The larvæ fed freely on both food plants in the first two stages, but from the end of second stage to the close of the experiment a preference was shown for witch-hazel.

The larvæ grew rather slowly and but few adults were obtained.

White Pine and Witch-hazel.

The larvæ fed moderately on witch-hazel in all stages, but none on pine during the first two stages. Later the feeding increased steadily to the end of the experiment.

The larvæ were of small size and but few adults were reared.

Poplar and Red Spruce.

The larvæ fed freely on the poplar in all stages, but very slightly on the spruce, no feeding being noted in the first two stages. They grew steadily and to fairly large size, and a small number reached the adult stage.

CLASSIFICATION OF FOOD PLANTS.

As a result of the experiments with single food plants and combinations, it is possible to draw up a classification of the trees and shrubs tested as regards their susceptibility to attack by the gipsy moth.

They have been arranged in the following classes:

Class I. Species that are favored food for the gipsy moth.

Class II. Species that are favored food for the gipsy moth after the early larval stages.

Class III. Species that are not particularly favored, but upon which a small proportion of the gipsy-moth larvæ may develop.

Class IV. Species that are unfavored food for the gipsy moth.

Class I.—*Species that are favored food for the gipsy-moth larvæ.*

Alder, Spreckled.
Apple.
Ash, Mountain.
Aspen, American.
Aspen, Large-toothed.
Balm-of-Gilead.
Beech, American.
Birch, Gray.
Birch, Paper.
Birch, Red.
Blueberry (V. *angustifolium*).
Box Elder.
Gum, Red.
Hawthorn.
Hazelnut.
Hazelnut, Beaked.
Larch, American.
Larch, European.
Linden, American.
Linden, European.
Oak, Black.
Oak, Rock Chestnut.
Oak, Dwarf Chestnut.
Oak, Bur.
Oak, Pin.
Oak, Post.
Oak, Red.
Oak, Scarlet.
Oak, Bear.
Oak, Shingle.
Oak, Swamp White.
Oak, White.
Poplar, Lombardy.
Rose, Pasture.
Service-berry.
Sumac, Mountain.
Sumac, Scarlet.
Sumac, Staghorn.
Willow, White.
Willow, Glaucous.
Willow, Sandbar.
Witch-hazel.

Class II.—*Species that are favored food for gipsy-moth larvæ after the earlier larval stages.*

Chestnut.
Hemlock.
Pine, Pitch.
Pine, Red.
Pine, Scotch.
Pine, Jack.
Pine, Western White.
Pine, White.
Plum, Beach.
Spruce, Black.
Spruce, Norway.
Spruce, Red.
Spruce, White.

CLASS III.—*Species that are not particularly favored but upon which a small proportion of the gipsy-moth larvæ may develop.*

Barberry, European.
Bayberry.
Birch, Black.
Birch, Yellow.
Blueberry, Low.
Blueberry, Tall.
Cherry, Sweet.
Cherry, Wild Black.
Cherry, Wild Red.
Chokeberry.
Choke Cherry.
Cottonwood.
Cranberry, American.
Elm, American.
Elm, European.
Elm, Slippery.
Fern, Sweet.
Gale, Sweet.
Gum, Black.
Hickory, Bitternut.
Hickory, Mockernut.
Hickory, Pignut.
Hickory, Shagbark.
Hornbeam, American.
Hophornbeam.
Maple, Norway.
Maple, Red.
Maple, Silver.
Maple, Sugar.
Pear.
Poplar, Silver.
Sassafras.

CLASS IV.—*Species that are unfavored food for gipsy-moth larvæ.*

Arbor Vitæ.
Arrowwood.
Arrowwood, Maple-leaved.
Ash, Black.
Ash, Blue.
Ash, Red.
Ash, White.
Azalea, White and Flame.
Balsam, Fir.
Blackberry, High.
Blue-flag, Larger.
Butternut.
Catalpa, Hardy.
Cedar, Red.
Cedar, Southern White.
Cornus.
Cranberry-tree.
Currant, Red.
Cypress, Bald.
Dangleberry.
Dock, Narrow.
Dogwood, Flowering.
Elder, American.
Eubotrys, Swamp.
Feverbush.
Grape.
Greenbrier.
Hackberry.
Hardhack, Pink.
Hardhack, White.
Holly, American White.
Honeysuckle, Bush.
Huckleberry, Highbush.
Inkberry.
Ivy, Poison.
Juniper, Common.
Kentucky Coffee-tree.
Laurel, Mountain.
Laurel, Sheep.
Locust, Black.
Locust, Honey.
Maple, Mountain.
Maple, Striped.
Mulberry, Red.
Mulberry, White.
Osage Orange.
Osier, Red.
Pepperbush.
Persimmon.
Privet.
Raspberry.
Sarsaparilla.
Skunk Cabbage.
Spice-bush.
Sweetbrier.
Sweet Pepper-bush.
Sycamore.
Tea, Appalachian.
Tulip-tree.
Viburnum, Sweet.
Walnut, Black.
Willow, Bay-leaved.
Winterberry, Smooth.

In arranging the foregoing classes it was not easy in all cases to assign a food plant according to this arbitrary classification. A number of species such as the poplars and hickories belong near the border line of Classes I and II, and they have been rated in the list which seems most appropriate. In general it can be said that whenever any of the trees or shrubs in Class IV are growing together no injury from gipsy-moth attack need be feared, and the same is true of Class II, or a combination of Classes II and IV. In case any of the species given in Class III are present there is a slight chance of injury resulting, but for practical purposes no difficulty is likely to be experienced by an owner so long as the species given in Class I are not present in his woodland or on his private grounds.

THE FOREST PROBLEM.

An examination of these classes, however, shows that the species noted in Class I are at present the dominant species in the woodlands in the area now infested with the gipsy moth. The oaks and birches predominate over much of this area, and this increases the difficulty of remedying the situation.

It will be noted that most of the species of high commercial value are included in Classes I and II. In arranging combinations which will resist moth attack it is necessary to consider the soil and other conditions suitable for their successful growth and to endeavor to bring about replacements with the least possible expenditure of money.

The encouragement of coniferous growth is to be commended provided the Class I trees can be eliminated. Experimental work with different stands of forest growth is being conducted by Mr. G. E. Clement, of the Bureau of Entomology, and practical advice to owners conveying the best methods of handling their wooded areas is being furnished.

It should be noted in examining the foregoing lists that, in addition to forest trees and shrubs, plants of much importance to horticulture and for ornamental and city planting are included. The problem is therefore broader than that of managing forests, as horticultural and shade-tree management should be adopted so that the least injury will result from the moth and that the least expense in controlling it will be necessary.

RECOMMENDATIONS FOR ORCHARD PRACTICE.

Among the horticultural crops most likely to be affected by the gipsy moth is the apple.

In moderate infestations the gipsy moth can be controlled by spraying with arsenate of lead, used at the rate of 10 pounds to 100

gallons of water. It should be applied as soon as the trees come into full leaf and will assist materially in controlling the codling moth. Improved methods of management and care of the trees will do much to decrease the danger from this pest. Hollow trees should be filled or cut, and all rubbish that will furnish convenient quarters in which the moths may deposit their eggs should be cleaned up and burned.

If the orchard infestation is serious, creosoting egg clusters and banding the trees with tanglefoot may be necessary.

During the past year a number of cases of severe injury to cranberries have been observed. This was caused by feeding of the caterpillars on the tender growth and cutting off the fruit buds and blossoms, which resulted in a serious decrease in the yield.

It is probable that this insect will not increase in sufficient numbers in cranberry bogs to kill the vines, and it has, therefore, been considered as able to survive on this plant (Class III). The money loss on account of diminution in yield is likely to be serious.

THE CITY PROBLEM.

On home grounds, in cities and parks, or on street or shade trees, this problem requires the expenditure of large sums of money if species favorable for the development of gipsy-moth caterpillars are to remain. Not only must the insect be reduced, so that injury to the trees will not result, but the caterpillar nuisance must be abated, particularly in the residential sections.

When future plantings are made, species should be selected which will not require a constant expenditure of money in order to keep them free from the moths. The lists given will furnish a guide in this respect.

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